



**Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS),
PUNE**

**Syllabus
for**

**T. Y. B. Sc. (Botany)
[NEP 1.0]
(B.Sc. Semester-V and VI)**

**With Effect From
2025-2026**



Deccan Education Society's

Fergusson College (Autonomous), Pune-4

Department of Botany

Semester	Paper	Paper Code	Title	Type	Credits	Exam Type
V	Major	BOT-301	Plant Anatomy and Embryology	Theory	2	CE+ESE
		BOT-302	Genetics and Plant Breeding	Theory	2	CE+ESE
		BOT-303	Cell and Molecular Biology	Theory	2	CE+ESE
	Elective	BOT-304 OR BOT-305	Conservation Biology OR Ethnobotany	Theory	2	CE+ESE
				Theory	2	CE+ESE
		BOT-306 OR BOT-307	Techniques in Plant Sciences OR Plant Resources and Management	Theory	2	CE+ESE
				Theory	2	CE+ESE
	Major	BOT-311	Botany Practical - 5	Practical	2	CE+ESE
		BOT-312	Botany Practical - 6	Practical	2	CE+ESE
	VSC	BOT-331	Horticulture And Floriculture	Theory	2	CE
		BOT-332	Botany Practical - 7	Practical	2	CE
	Minor	BOT-321	Fundamentals of Plant Anatomy and Embryology	Theory	2	CE+ESE
	FP	BOT-345	Field Project	Theory/ Practical	2	CE
VI	Major	BOT-351	Plant Systematics and Paleobotany	Theory	2	CE+ESE
		BOT-352	Plant Disease Management	Theory	2	CE+ESE
		BOT-353	Basics of Plant Biotechnology	Theory	2	CE+ESE
	Elective	BOT-354 OR BOT-355	Medico Botany OR Biofertilizers	Theory	2	CE+ESE
				Theory	2	CE+ESE
		BOT-356 OR BOT-357	Computational Botany OR Seed Technology	Theory	2	CE+ESE
				Theory	2	CE+ESE
	Major	BOT-361	Botany Practical - 8	Practical	2	CE+ESE
		BOT-362	Botany Practical - 9	Practical	2	CE+ESE
	VSC	BOT-382	Botany Practical - 10	Practical	2	CE
	Minor	BOT-371	Plant Biotechnology	Theory	2	CE+ESE
	OJT	BOT-395	On Job Training	Theory/ Practical	4	CE

T. Y. B. Sc. Semester V		
	BOT 301-Plant Anatomy and Embryology Major-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define, list and identify different tissues and its functions.	1
CO2	Explain pollination and fertilization in plants. Distinguish normal and anomalous secondary growth in plants.	2
CO3	Generalize the steps involved in sporogenesis in flower. Interpret the normal and anomalous secondary growth in angiosperms.	3
CO4	Specify embryological stages of the life cycle of higher plants. Write applications of plant anatomy and embryology.	4

**BOT 301-Plant Anatomy and Embryology
(Major-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Plant Anatomy Introduction and scope of Plant Anatomy, Applications in systematics, forensics and pharmacognosy	02
II	Meristematic and permanent tissues Simple (parenchyma, collenchyma, sclerenchyma) and complex tissues (xylem, phloem)	02
III	Normal and Abnormal (anomalous) secondary growth Introduction and concept of primary growth and secondary growth, Vascular cambium- structure and function, seasonal activity, Normal Secondary growth in Dicot stem Abnormal Secondary growth in Dicot stem e.g., <i>Cucurbita</i> , <i>Boerhaavia</i> .	08
IV	Introduction to Embryology Introduction and scope of plant embryology, Applications in Taxonomy, Plant Tissue Culture and Plant Breeding.	02
V	Sporogenesis in flower Structure of anther and pollen, Microsporogenesis and Microgametogenesis, Structure and types of ovule, Megasporogenesis and Megagametogenesis, Types of embryo sac development - Monosporic, Bisporic and Tetrasporic.	08
VI	Pollination and Fertilisation Types of Pollination – Contrivances, Seed structure appendages and dispersal mechanism (Any 3), Double fertilisation – Process and significance.	06
VII	Embryo and Endosperm Embryo: Structure of dicot and monocot embryo (Development not expected), Endosperm: Types – Nuclear, Cellular and Helobial.	02

Learning Resources:

Sr. No.	References
1	Adrian S Foster - Practical Plant Anatomy, D Van Nostrand Co. INC, New York.
2	B P Pandey- Plant Anatomy, S Chand and Co. Ltd, New Delhi.
3	Bhojwani S S and Bhatnagar S P - An Embryology of Angiosperms, Vikas Publishers.
4	Chandurkar P J- Plant Anatomy Oxford and IBH publication Co. New Delhi.
5	Eames and Mc Daniel -, An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan.
6	Esau - Plant Anatomy, Wiley Toppan Co. California, USA.
7	Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo.
8	Maheshwari P - An introduction to Embryology of Angiosperm, Alpha Edition.
9	Pandey S N and Ajanta Chadha - Plant Anatomy and Embryology, Vikas Publishing House, Pvt. Ltd, New Delhi.
10	Pijush Roy - Plant Anatomy, New Central Book Agency Ltd, Kolkata

	BOT 302-Genetics and Plant Breeding	
	Major-Theory	
	Number of Credits: 02	
	Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the concepts of genetics and plant breeding.	1
CO2	Summarize Mendelian genetics, interaction of genes, quantitative and cytoplasmic inheritance.	2
CO3	Classify breeding methods, mutation and mutagens, linkage, crossing over and chromosomal changes.	3
CO4	Analyze the role of genetics and plant breeding in crop improvement.	4

BOT 302-Genetics and Plant Breeding
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	Genetics-Introduction Definition, Concept of heredity and variations Mendelian genetics: Genetical terminology, Monohybrid cross, Law of dominance, Incomplete dominance and co-dominance, Law of segregation/law of purity of gametes, Dihybrid cross, Law of independent assortment, Back-cross and Test cross.	4
II	Interactions of genes Non-epistatic genetic interactions- complementary genes (9:7), Duplicate Genes (15:1), Epistatic genetic interactions- Masking genes (12:3:1), Supplementary genes (Recessive epistasis) (9:3:4), Inhibitory genes (13:3), Lethal genes (2:1); Multiple Alleles: concept, characters of multiple alleles, example- self-incompatibility in <i>Nicotiana</i> .	6
III	Quantitative and Cytoplasmic Inheritance Quantitative Inheritance: concept of quantitative inheritance Difference between qualitative and quantitative traits, Inheritance of quantitative trait in Maize (Cob length) Cytoplasmic inheritance: Definition and concept, Chloroplast-Variegation in Four O'clock plants, Mitochondria- Petite mutants in Yeast.	3
IV	Linkage and crossing over Linkage- Definition and Types, Crossing over: Definition and Types, Construction of a linkage map by two-point test cross and three-point test cross.	3
V	Structural and Numerical Changes in Chromosomes Structural changes in chromosomes: deletion, duplication, inversion, translocation. Numerical changes in chromosomes: Euploidy: Monoploidy, polyploidy - autopolyploids, allopolyploids, synthesized allopolyploids (wheat and cotton) ; Aneuploidy : monosomy, nullisomy, trisomy in <i>Datura</i> .	4
VI	Plant Breeding Objectives, scope and importance; Plant introduction (Primary and Secondary), and acclimatization.	1

VII	Breeding Methods Self- pollinated crops: Mass selection, Pure-line selection, Pedigree method, Bulk method, Backcross method. Cross-pollinated crops: Mass selection, Progeny Selection, Recurrent selection. Clonally propagated plants: Clonal selection Hybridization-procedure, Heterosis (dominance hypothesis) and hybrid vigour.	6
VIII	Mutation in Crop Improvement Types of mutations - spontaneous and induced mutations, Types of mutagens - chemical and physical mutagens, Mechanism of action, Applications.	3

Learning Resources:

Sr. No.	References
1	Allard, R.W. (1999). Principles of Plant Breeding. John Wiley, New York
2	Chahal G.S. and Gosal S.S. (2008). Principles and Procedures of Plant Breeding, Narosa Publishing House, New Delhi
3	Chaudhari, H. K. (1984). Elementary Principles of Plant Breeding, 2nd Ed., Oxford – IBH.
4	Chopra, V.L. (2023). Plant Breeding: Theory and Practice 2nd Restructured Edition, New India Publishing Agency, New Delhi.
5	Gardner E. J., Simmons M. J., Snustad D. P. (2008). Principles of Genetics. 8th Edition Wiley India.
6	Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, 10th edition. San Francisco, California: Benjamin Cummings
7	P. K. Gupta (2017). Genetics, Rastogi Publication, Meerut.
8	P.S. Verma and V. K. Agarwal (2010). Genetics, S. Chand Publication, New Delhi
9	Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops, 4th Ed. Panima Publishing Corporation, New Delhi.
10	Sharma J.R. (1994). Principles and practices of Plant Breeding. Tata McGrawHill Publishers Company Ltd., New Delhi.
11	Singh, B.D. (2022). Plant Breeding: Principles and Methods, 12th edition. New Delhi, Delhi: Kalyani Publishers.
12	Snustad, D. P. and Simmons, M. J. (2019). Principles of Genetics. 7th edition. Chichester, England: John Wiley and Sons
E-Resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-303-Cell and Molecular Biology Major-Theory	
	Number of Credits: 02 Number of Hours: 30	
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's cognitive level
CO1	Describe the structure and functions of a plant cell and its different cellular components along with the cell cycle.	1
CO2	Categorise the nature of biomolecules and types of genetic materials.	2
CO3	Apply knowledge of molecular processes like replication, transcription and translation to understand cellular functions.	3
CO4	Explain the cellular functions with respect to genes, its expression and regulations.	4

**BOT-303-Cell and Molecular Biology
(Major-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Cell as a unit of life with molecular processes Definition and comparison of prokaryotic and eukaryotic cells Central Dogma in Molecular Biology Model organisms Definition and scope of cell biology and molecular biology	2
II	Plant cell wall and cell membrane Ultrastructure and functions – Cell wall Cell membrane	2
III	Overview of cell organelles Structural organisation and functions of Chloroplast, Mitochondria, Endoplasmic Reticulum, Golgi Apparatus, Vacuole and Microbodies	3
IV	Outline of nucleus and chromosomes Nucleus – ultrastructure, nuclear pore complex and functions Chromosome – structure, Euchromatin and Heterochromatin	2
V	Cell Division Phases of Cell Cycle Mitosis and Meiosis	2
VI	Biomolecules of the cell Introduction and structural role of carbohydrates, lipids and proteins in the cell.	2
VII	Nature and function of Genetic Material / Nucleic Acids Biological evidences to prove DNA – transformation and transduction Watson and Crick's Model of DNA Forms of DNA – A, B and Z Structure and role of mRNA, rRNA and tRNA Introduction to miRNA Comparison of DNA and RNA as genetic material	4
VIII	DNA replication Types and Messelson and Stahl's experiment	3

	DNA Replication in Prokaryotes – Molecular mechanism and key enzymes	
IX	Transcription in Prokaryotes Structure of Gene Structure of promoter and terminator Transcription apparatus and Role of RNA Polymerase Overview of mechanism of transcription	4
X	Translation - Protein Synthesis Genetic code – Definition, Concept and Properties Structure of ribosomes and their function Overall mechanism of translation process in prokaryotes Initiation, Elongation and Termination	4
XI	Gene Expression and Regulation Introduction to gene regulation in prokaryotes The Lac Operon: A model for gene regulation in bacteria	2

Learning Resources:

Sr. No.	References
1.	S. C. Rastogi (2006). Cell and Molecular Biology, New Age International (P) Limited .
2.	P. S. Verma and V. K. Agarwal (1999). Cytology, S. Chand Publishing.
3.	C. B. Powar (2010). Cell Biology, Himalaya Publishing House.
4.	P. K. Gupta (2005). Cell and Molecular Biology, Rastogi Publications.
5.	Veer Bala Rastogi (2010). Fundamentals of Molecular Biology, Ane Books Pvt. Ltd.
6.	G. K. Pal and Ghaskadabi (2009). Fundamentals of Molecular Biology, Oxford University Press India.
7.	Robertis and DeRobertis (2017). Cell and Molecular Biology, Wolters Kluwer India Pvt. Ltd.
8.	Bob. B Buchanan (2015). Biochemistry and Molecular Biology of Plants, 2 nd Edition, Wiley.
9.	Stephen L. Wolfe (1993). Molecular and Cell Biology, Wadsworth Publishing Company.
E-Resources	https://www.nature.com/subjects/cell-biology https://ocw.mit.edu/courses/res-7-007-7-06x-cell-biology/ Pearson Education, Molecular Cell biology, Lodish Darnell -5th ed, W H Freeman Molecular Biology, Clark and Pazdernik, Elsevier and Academic Press

	BOT-304-Conservation Biology Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the foundational concept of biodiversity with respect to its characterisation and loss	1
CO2	Understand the effects of the biodiversity crisis and the role of pollution in biodiversity.	2
CO3	Apply conservation strategies and current practises to real-world environmental issues and case studies.	3
CO4	Analyse the role of public participation and sustainable practices in conservation efforts.	4

**BOT-304-Conservation Biology
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Biodiversity Introduction and Concept of Biodiversity Aims and Objectives Scope and Values of Biodiversity	2
II	Characterization of Biodiversity Need for characterization of Biodiversity Various levels of Biodiversity – Genetics, Species and Ecosystem Concept of Endemism Biodiversity Hotspots in world	3
III	Loss of Biodiversity Concept and factors affecting – Loss of genetic diversity, species diversity, ecosystem diversity, agrobiodiversity	2
IV	Biodiversity crisis Founder Effects Genetic Drift Inbreeding Depression IUCN Categories - RET Plants (Red Data Book)	4
V	Impact of Pollution on Biodiversity Greenhouse Effect, Global Warming, Ozone Depletion Acid Rain, Eutrophication and their impacts on biodiversity	3
VI	Current Practices in Conservation In-situ Conservation - International efforts and Indian initiatives, protected areas in India, concept of Biosphere Reserves, National Parks and Biodiversity Park, Wetlands, Mangroves and Coral Reefs Ex-situ Conservation - Germplasm collections, Botanical Gardens - Lead Botanical Gardens, Seed bank, Gene bank, Pollen bank and DNA bank	8

VII	Conservation Strategies and Case Studies Basic Concepts of Conservation Biology Reserve Design and Protected Areas Case Study: Project Great Indian Bustard Case Study: Passenger Pigeons Lake Restoration CBD-Ramsar	6
VIII	Public Participation and Environmental Movements Sacred Groves Avenue Trees 'Chipko' Movement 'Rahibai' Seed Conservation	2

Learning Resources:

Sr. No.	References
1	Krishnamurthy, K. V. (2003). An Advanced Textbook on Biodiversity - Principles and Practice, Oxford and IBH Publication, New Delhi.
2	Hajra, P. K. and Mudgal, V. (1997). Plant Diversity Hotspots in India - An Overview, BSI.
3	John R. Jensen, Remote Sensing of the Environment (2000). Dorling Kindersley India Pvt. Ltd.
4	Current Sciences Special Issue Remote Sensing for National Development, Volume 61, Numbers 3 and 4, August 1991.
5	Kumar, H. D., (1996). Modern Concepts of Ecology, (3rd edition), Vikas Publishing House Pvt. Ltd., Delhi
6	Kumar, H. D., (1997). General Ecology, Vikas Publishing Pvt. Ltd., Delhi.
7	Kermondy, F. J., (1996). Concepts of Ecology, Prentice Hall India Pvt. Ltd., New Delhi
8	M. Anji Reddy, Textbook of Remote Sensing and GIS, (2006). B. S. Publication, Hyderabad.
E-Resources	iscnagpur.ac.in/study_material/1.8 SAK Conservations of Biodiversity EX-SITU IN SITU%5B1%5D.pdf/ https://www.irejournals.com/formatedpaper/1702448.pdf https://www.iucnredlist.org/ https://dst.gov.in/sites/default/files/SEED%20Mother%20Rahibai%20gets%20Padmashree.pdf

	BOT-305-Ethnobotany Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify the concept, scope and interdisciplinary nature of ethnobotany and list the ethnic groups of India with their plant uses.	1
CO2	Explain the role of ethnobotany in modern medicine and describe the significance of plants in ethnobotanical practices.	2
CO3	Apply ethnobotanical knowledge to assess the role of ethnic groups in conserving plant genetic resources and forest management.	3
CO4	Analyse the legal aspects of ethnobotany.	4

**BOT-305-Ethnobotany
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Ethnobotany Introduction, concept, scope and objectives, Ethnobotany as an interdisciplinary science. The relevance of Ethnobotany in the present context, Major and minor Ethnic groups or tribals of India and their lifestyles, Plants used by the tribals: Food plants, Intoxicants and Beverages, Resins and oils, Miscellaneous uses.	6
II	Role of Ethnobotany Role of Ethnobotany in modern medicine, Medico and ethnobotanical sources in India, Significance of the following plants in ethno-botanical practices along with their habitat and morphology: <i>Azadirachta indica</i> , <i>Ocimum sanctum</i> , <i>Vitex negundo</i> , <i>Gloriosa superba</i> , <i>Tribulus terrestris</i> , <i>Pongamia pinnata</i> , <i>Cassia auriculata</i> , <i>Indigofera tinctoria</i> . Role of Ethnobotany in modern medicine with special examples: <i>Rauvolfia serpentina</i> , <i>Trichopus zeylanicus</i> , <i>Artemisia annua</i> , <i>Withania somnifera</i> , <i>Tinospora cordifolia</i> . Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (Participatory forest management)	10
III	Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.	8
IV	Research Methods in Ethnobotany Field Work, Herbarium, Ancient Literature, Archaeological findings, Religious and sacred places	6

Learning Resources:

Sr. No.	References
1	Colton, C. M., 1997, Ethnobotany - Principles and Applications, John Wiley and Sons, Chichester.
2	Jain S. K., 1981, Glimpses of Indian Ethnobotany, Oxford and IBH, New Delhi.
3	Jain S. K., 1981, Glimpses of Indian Ethnobotany, Oxford and IBH, New Delhi.
4	Jain, S. K., 1995, Manual of Ethnobotany, Scientific Publishers, Jodhpur
E-Resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-306-Techniques in Plant Sciences Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	State the principle of techniques used in plant sciences.	1
CO2	Discuss the components / methods of different techniques.	2
CO3	Illustrate the working and applications of various techniques.	3
CO4	Explain the techniques for detection of proteins and nucleic acids.	4

**BOT-306-Techniques in Plant Sciences
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
1	Microscopy Introduction, purpose of microscopic examination, Compound microscope - components, working, optic principle and uses. Stereomicroscope-construction, optic principle and uses. Introduction to Electron microscopy	4
2	Chromatography Introduction, concept of partition coefficient, principle, method and applications of Paper Chromatography, Column chromatography, Thin Layer Chromatography, Ion-exchange chromatography, Molecular sieve chromatography, Affinity chromatography.	6
3	Spectrophotometry Introduction, Beer and Lambert's law, principle, working and applications of Visible, UV and IR spectrophotometry.	5
4	Centrifugation Introduction, Basic principles of sedimentation, types of rotors, differential and density gradient centrifugation, sucrose density gradient, analytical centrifugation, ultracentrifugation, applications.	6
5	Electrochemical Techniques pH meter- principle, electrodes (reference electrode, indicator electrode), working of pH meter, calibration of pH meter, applications.	3
6	Techniques for detection of proteins and nucleic acids Electrophoresis: principle, method and application of Agarose Gel Electrophoresis (AGE), Polyacrylamide Agarose Gel Electrophoresis, SDS-PAGE; Southern blotting, Polymerase Chain Reaction (PCR)	6

Learning Resources:

Sr. No.	References
1	Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2	Wilson, K and Walker, J (2010). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.
3	K. R. Aneja (2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi
4	C. S. Patil (2017). Advanced Analytical Techniques, ABE Books, New Delhi.
E-resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-307-Plant Resources and Management Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
	Course Outcomes (COs) On completion of the course, the students will be able to:	Bloom's cognitive level
CO1	Identify and explain the various plant resources and their industrial applications and understand the connection between material wealth & resource exploitation.	1
CO2	Describe the principles of bio-control mechanisms and greenhouse technologies, analyze their advantages and limitations.	2
CO3	Apply the principles of floral arrangements and evaluate weed management methods, including their control and sustainable use.	3
CO4	Evaluate the relationship between economic growth and environmental degradation, and assess strategies for sustainable resource use.	4

**BOT-307-Plant Resources and Management
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Plant Resources Introduction. Plant resources and industries: medicine (<i>Rauwolfia</i> & <i>Vinca</i>), timber (Teak & Sisam), dyes (Henna & <i>Bixa</i>), gum (<i>Acacia arabica</i> & Guar gum) and tannins (<i>Acacia catechu</i> & <i>Terminalia chebula</i>), aromatic (<i>Geranium wallichianum</i> & <i>Citronella</i>), fodder (Alfa-alfa & Maize),	4
II	Forest as potential resource Introduction and scope Major forest produce and their uses - Fuel, Paper (two examples of each) Minor forest produce and their uses, – Essential oil (sandal wood, Eucalyptus oil), Spices (Cardamom, Nutmeg), and pigments	4
III	Floral arrangement Introduction, principles, types – social, formal and non-formal, selection of materials used, vase life improvement. Flower arrangement as a business opportunity.	3
IV	Bio-control Introduction, advantages General mechanism Important commercial products – Source, preparation, mode of action and uses of Pyrethrin, Azadirachtin, Trichoderma, Trichogramma	4
V	Greenhouse technology Introduction, advantages and limitations Types of greenhouses	5

	Greenhouse structure, principle- i) Site selection and orientation; ii) Structure materials; iii) Covering materials; iv) Temperature and humidity control	
VI	Weed management Introduction and need Invasive weeds - concept and causes of their dominance Weed control – Physical, chemical and biological Methods, Sustainable use of weeds	4
VII	Bio-fuel Technology Introduction and advantages. Concept of bio-fuel and its need. Plants used for bio-fuel production. Biodiesel production from Castor	3
VIII	Industrial Mycology Introduction Important genera of fungi used in various Industries and their products. Products and applications of <i>Ganoderma</i> , <i>Penicillium</i> , <i>Aspergillus</i> and Yeast.	3

Learning Resources

Sr. No.	References
1	Textbook of Economic Botany, Verma V., Ane Books Pvt. Ltd.
2	Economic Botany in the Tropics, Kochhar, Macmillan Publisher.
3	Economic Botany: Principles and Practices, Gerald E. Wickens, Springer Publication.
4	Floriculture in India, Gurcharan Singh Randhawa and Amitabha Mukhopadhyay, Allied Publishers.
5	Floriculture Marketing in India, Debashish Sengupta and Raj Kamal, Excel Books.
6	Floriculture Hand Book, Eiri, Engineers India Research in Publication.
7	Pathak, Khatri, Pathak, 2003, Fundamentals of plant pathology, Agrbios
8	Mehrotra, R.S. 1991, Plant Pathology, Tata Mc-Graw Hill Co. Delhi
9	Chatterjee, P.B., 1997, Plant Protection Techniques, Bharati Bhawan, Publ. Patana
10	Agrios, G.N. 2006 Plant Pathology, Elsevier Academic Press.
11	Pandey, B.P. 2009, Plant Pathology, S. Chand Co.
12	Gupta, G.P., 2004, Text book of plant diseases, Discovery Publ. House, New, Delhi
13	Singh, R.S. 2004, Plant Diseases, Oxford & IBH Publishing Co. Pvt. Ltd., Delhi.
14	Zhiqiang A.N. (2004) Handbook of Industrial Mycology. CRC Press
15	Gary Leatham (1993) Frontiers in Industrial Mycology. Springer
E-resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT 311-Botany Practical -5 Major -Practical	
	Number of Credits: 02 Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify the different types of tissues and Mendels law through seed ratios.	1
CO2	Differentiate between the types of ovules, tetrasporangiate anther, dicot, monocot embryo and gene interactions.	2
CO3	Describe the concept of embryology and incomplete dominance.	3
CO4	Prepare double stained temporary preparation of transverse section of stem of <i>Annona</i> , <i>Bignonia</i> and <i>Dracaena</i> and specify the type of secondary growth and construct linkage maps.	4

**BOT 311-Botany Practical -5
(Major –Practical)**

Practical no.	Title of the Practical
1.	Dissection & isolation of meristem from <i>Hydrilla</i>
2.	Study of Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3.	Study of normal secondary growth as per suitable material. (Double stained temporary preparation).
4.	Study of anomalous secondary growth in <i>Cucurbita</i> and <i>Boerhaavia</i> stem. (Double stained temporary preparation).
5.	A. Dissection and isolation of stamen and carpel. B. Study of pollen germination.
6.	A. Study of tetrasporangiate anther – T.S. of mature anther (Permanent slides, photographs) B. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous. (Permanent slides, photographs)
7.	Study of dicotyledonous and monocotyledonous embryo (Specimen).
8.	Female gametophyte: <i>Polygonum</i> (monosporic) type of Embryo sac (Permanent slides/photographs).
9.	Study of Mendel's laws through seed ratios (monohybrid and dihybrid crosses)
10.	Study the incomplete dominance and gene interaction through following seed ratios (9:7, 13:3).
11.	Study of gene interaction through following seed ratios (15:1, 12:3:1, 9:3:4).
12.	Construct the linkage maps based on three-point test cross.

Note: 10 Compulsory Practicals + 1 Activity (Equivalent to 2 Practicals)

	BOT-312-Botany Practical -6 Major -Practical	
	Number of Credits: 02 Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall key concepts of cell size measurement, stages of mitosis, meiosis, cytoplasmic inheritance, autopolyploidy and hybridization.	1
CO2	Explain the techniques of micrometry and Lowry method.	2
CO3	Demonstrate the ability to conduct experiments like protoplasmic streaming and DNA/RNA estimation.	3
CO4	Interpret the concept of heterocatalytic activity of DNA by problem solving techniques.	4

**BOT-312-Botany Practical -6
(Major –Practical)**

Practical no.	Title of the Practical
1.	Measurement of cell size by the technique of micrometry
2.	Demonstration of protoplasmic streaming
3.	Study of C metaphase (from colchicine pre-treated onion root tip cells)
4.	Study of various stages of meiosis
5.	Estimation of soluble proteins by Lowry / Bradford method
6.	Isolation of Plant Genomic DNA extraction from cauliflower
7.	Estimation of Plant DNA by DPA method
8.	Estimation of RNA by Orcinol method
9.	Problem solving based on DNA transcription and translation
10.	Study of cytoplasmic inheritance - Variegation in Four O'clock plants
11.	Induction of autopolyploid in <i>Allium cepa</i> by colchicine
12.	Study of Translocation Ring and Inversion Bridge with the help of photographs/specimen
13.	Demonstration of hybridization techniques by using suitable flower material.

Note: 10 Compulsory Practicals + 1 Activity (Equivalent to 2 Practicals)

	BOT-331-Horticulture and Floriculture VSC-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the concepts of horticulture and floriculture.	1
CO2	Classify the horticultural crops and discuss their nutritive values.	2
CO3	Examine the importance of conservation and cultivation of wild plants in landscape gardening. Apply the knowledge of drying plant material and discuss their applications.	3
CO4	Analyse different practices in horticulture and explain their applications with respect to different crops.	4

BOT-331-Horticulture and Floriculture
(VSC-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Horticulture Definition and branches, Scope and economic importance of horticultural crops, Export and import potential of horticultural crops, Horticultural zones of India and Maharashtra, Global and National Scenario of horticulture	02
II	Study of gardening tools Media preparation for nursery bed and potting Plant Propagation: Methods of plant propagation Sexual and vegetative propagation- Cutting, layering, grafting, budding Suckers, rhizomes, tubers, runners, bulbs, corms, stolons, bulbils	04
III	Special Practices in Horticulture Training and Pruning - Objectives, types, systems of trainings Fruit crops - Special practices like Bahar treatment, Girdling, Notching, Ringing, Bending, Vegetable crops special practices - Earthing up, Staking and Blanching	03
IV	Introduction to Fruits and Vegetables Production Technology Soil and climate requirements, Commercial varieties, Harvesting and post harvesting management, Plant protection methods, Fruits - Banana and Mango, Vegetables – Root – Raddish, Stem- Navacol and Leafy vegetables-- Moringa	05
V	Introduction to ornamentals and Landscaping Gardening Introduction of wild plants as garden plants, Successful stories of cultivation of 25 wild plants of ornamental value from Western Ghats, Landscaping Places of public importance, Landscaping highways and educational institutions	05
VI	Introduction to Floriculture Definition and Concept, Scope and Importance of Floriculture	06

	Important floriculture crops, Methods of cultivation for - Jasmine, Marigold, Tuberose Use of Greenhouse Technology for cultivation of flowers - <i>Chrysanthemum</i> , <i>Dahlia</i>	
VII	Flower Industry Dry Flowers. Introduction, Indian market of dry flowers, selection of material, Techniques of drying - Air drying, sun drying, Press drying, desiccants, oven and microwave drying methods, Preservation methods- bleaching, dyeing and painting, Storage, care of dried flowers etc. Dry flower arrangement and drift wood arrangement Cut Flowers. Introduction, Species and cultivars of Orchids, <i>Anthurium</i> and <i>Heliconia</i> , Harvesting techniques, Mode of harvesting, Post-harvest handling - Conditioning, precooling, pulsing and impregnation, grading, bunching, wrapping, packing and cold storage, transport of cut flowers, Indian market of cut flowers	05

Learning Resources:

Sr. No.	Reference Books
1	Sheela, V. L., Horticulture, MJP Publications.
2	Hartmann and Koster's Plant Propagation, Principles and Practices
3	Kunte, Y. N., Kawathalkar M. P. and Yawalkar, K. S., Principles of Horticulture and Fruit Growing, Agri-Horticultural Publication House, Nagpur.
4	Arora, J. S., Introductory Ornamental Horticulture, Kalyani Publications.
5	Bose, T. K. and Yadav, L. P., Commercial Flowers, Naya Prakashan
6	Singh, B. D., Plant Breeding, Kalyani Publications.
7	Chadha, K. L. and Pareek, O. P., Advances in Horticulture, Vol. IV, Malhotra Publications.
8	Sudheer, K. P. and Indira V, Post-Harvest Technology of Horticultural Crops, New Delhi Publications.
9	Adams, C. R., Principles of Horticulture, Elsevier Publication, 4th edition, 2004.
10	Gurcharan Singh, Randhawa and Amitabha Mukhopadhyay, Floriculture in India, Allied Publishers.
11	Debashish Sengupta and Raj Kamal, Floriculture Marketing in India, (Excel Books). 5. Vashishta P. C., (2006). Pteridophytes S.Chand and Co.

	BOT-332-Botany Practical -7 VSC-Practical	
	Number of Credits: 02 Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify various vegetative propagation techniques.	1
CO2	Discuss various study techniques used in horticulture	2
CO3	Classify tools used in horticulture and floriculture	3
CO4	Explain media preparation for plants.	4

**BOT-332-Botany Practical -7
(VSC-Practical)**

Unit No.	Title of Unit and Contents
1	Identification of Garden tools, implementations and protection items
2	Study of cutting, air layering
3	Study of grafting (Whip, tongue, stone)
4	Study of Budding (Patch and T budding)
5	Study of Technique- Training and Pruning
6	Methods of making dry flowers
7	Media preparation for plant propagation in nursery beds, potting and repotting
8	Study of wild ornamentals (any 5)
9	Cultivation and submission of at least one wild ornamental plant
10	Plant propagation by vegetative structures (bulbs, corms, tubers, tuberous roots and rhizomes)
11	To identify various cut and loose flowers crops based on primary and morphological characters
12	Visit to nursery

Note: 10 Compulsory Practicals + 1 Activity (Equivalent to 2 Practicals)

	BOT-321-Fundamentals of Plant Anatomy and Embryology Minor-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define, list and identify different tissues and its functions.	1
CO2	Explain pollination and fertilization in plants. Distinguish normal and anomalous secondary growth in plants.	2
CO3	Generalize the steps involved in sporogenesis in flower. Interpret the normal and anomalous secondary growth in angiosperms.	3
CO4	Specify embryological stages of the life cycle of higher plants.	4

**BOT-321-Fundamentals of Plant Anatomy and Embryology
(Minor-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Plant Anatomy Introduction and scope of Plant Anatomy.	02
II	Meristematic and permanent tissues Simple (parenchyma, collenchyma, sclerenchyma) and complex tissues (xylem, phloem)	02
III	Normal and Abnormal (anomalous) secondary growth Introduction and concept of primary growth and secondary growth, Vascular cambium- structure and function, seasonal activity, Secondary growth in Dicot stem e.g., <i>Annona squamosa</i> , Abnormal Secondary growth in Dicot stem e.g., <i>Bignonia</i> .	08
IV	Introduction to Embryology Introduction and scope of plant embryology.	02
V	Sporogenesis in flower Structure of anther and pollen, Microsporogenesis and Microgametogenesis, Structure and types of ovule, Megasporogenesis and Megagametogenesis, Types of embryo sac development - Monosporic.	08
VI	Pollination and Fertilisation Types of Pollination – Contrivances, Seed structure appendages and dispersal mechanism (Any 3), Double fertilisation – Process and significance.	06
VII	Embryo and Endosperm Embryo: Structure of dicot and monocot embryo (Development not expected), Endosperm: Types – Nuclear, Cellular and Helobial.	02

Learning Resources:

Sr. No.	Reference Books
1	Chandurkar P J- Plant Anatomy Oxford and IBH publication Co. New Delhi.
2	B P Pandey- Plant Anatomy, S Chand and Co. Ltd, New Delhi.
3	Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo.
4	Eams and Mc Danie -, An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan.
5	Adriance S Foster - Practical Plant Anatomy, D Van Nostrand Co. INC, NewYork.
6	Esau - Plant Anatomy, Wiley Toppan Co. California, USA.
7	Pijush Roy - Plant Anatomy, New Central Book Agency Ltd, Kolkata.
8	Pandey S N and Ajanta Chadha - Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi.
9	Bhojwani S S and Bhatnagar S P - An Embryology of Angiosperms, Vikas Publishers.
10	Maheshwari P - An introduction to Embryology of Angiosperm, Alpha Edition.

BOT-345 Field Project Field Project Theory/Practical
Number of Credits: 04 No. of Hours: 60

T. Y. B. Sc. Botany SEM VI		
	BOT 351-Plant Systematics and Paleobotany Major- Theory	Credits: 02 Hours: 30
	Number of Credits:02 No of Hours:30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Outline the position of angiosperms in the latest classification system.	1
CO2	Classify the groups and differentiate the taxonomic forms.	2
CO3	Interpret the types of fossils with reference to living plants	3
CO4	Distinguish different families with reference to systematic position, characters and their economic importance.	4

BOT 351-Plant Systematics and Paleobotany
(Major- Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction of Angiosperms Origin with reference to time, place and ancestry, Pteridosperm theory, Bennettitalean theory and Gnetalean theory	02
II	Systematics - An Interdisciplinary Science Relevance of palynology, cytology, phytochemistry and molecular data	04
III	Systems of Classification Types of classification systems: Pre and post historic period Detail outline of APG system of classification	02
IV	Study of Families Introduction, Study of families with reference to systematic position, Distinguishing characters, economic importance, General floral formula, floral diagram of following, Families: Magnoliaceae, Capparidaceae, Acanthaceae, Lamiaceae, Bignoniaceae, Verbenaceae, Convolvulaceae, Rubiaceae, Nyctaginaceae, Orchidaceae and Cannaceae	10
V	Plants Identification Latin Diagnosis, Practicing indented and bracketed keys, Plant authentication	02
VI	Palaeobotany Geological time scale, form, genera, concept and nomenclature	01
VII	Fossils Definition and process of fossil formation, Conditions favourable for fossilization, Types of fossils – Impression, Compression, Petrification, Pith cast and Coal ball, Amber, Chemical Fossil, Pseudofossil and Microfossil.	03
VIII	Study of Fossil Plant Groups by comparing with extant plants Psilopsida - Salient features of order Psilophytales, External and internal morphology of <i>Rhynia</i> , Sphenopsida -Salient features of Calamitales, External and internal morphology of <i>Calamities</i> , Pentoxylae - Salient features, external and, Internal morphology of stem (<i>Pentoxylon</i>). Leaf (<i>Niphanionphyllum</i>)	06

Learning Resources:

Sr. No.	Reference Books
1	Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons, Ltd., London.
2	Lawrence, G.H. M. (1955). An Introduction to Plant Taxonomy.
3	Pande. B. P. (1997). Taxonomy of Angiosperms. S. Chand and Co.
4	Naik, V. N. (1985). Taxonomy of Angiosperms.
5	Yadav. S. R. and Sardesai M. R. (2000) Flora of Kolhapur District.
6	Theodore Cooke. (1903). The Flora of the Presidency of Bombay – Vol. I, II and III.
7	Arnold, C. R. (1990). An Introduction to Palaeobotany.
8	Shukla. A. C. and Mishra. S. P. (1995). Essentials of Palaeobotany.
9	Simpson, M. G. (2019). Plant systematics. 3rd Edition, Academic press.
10	Singh, G. (2019). Plant Systematics- An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.
11	Stuessy, T.F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, 2nd edition, Columbia University Press.
12	Taylor, D.V., Hickey, L.J. (1997) Flowering Plants: Origin, Evolution and Phylogeny. 8 CBS Publishers & Distributors, New Delhi.
13	Pandey, A. K., Kasana, S. (2021). Plant Systematics. 2nd Edition. CRC Press Taylor and Francis Group

	BOT-352-Plant Disease Management Major-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define plant disease terminology and describe various plant pathogens.	1
CO2	Identify and classify plant diseases based on symptoms and pathogen characteristics.	2
CO3	Assess and implement integrated disease management strategies for effective control of plant diseases.	3
CO4	Apply Koch's postulates and advanced diagnostic techniques for plant disease management.	4

**BOT-352-Plant Disease Management
(Major-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Plant Diseases Definition, Important terminology- (Incitants, Host, Sign, Symptoms, Parasite, Pathogen, Inoculum, Penetration, Infection, Incubation, Disease. Disease development, Endophyte, Predisposition, Suscept, Resistance, Epidemic, Etiology, Pathogenicity, Inanimate and animate disease, Disease triangle). Types of plant pathogens- Viruses, Bacteria, Fungi, Phytoplasma, Nematodes. General characters, Symptoms of plant diseases, Transmission of Plant pathogens, Host-parasite interactions. Significance of plant diseases.	4
II	Plant Disease Diagnosis Koch's Postulates; Plant disease symptoms and types (Necrosis, Hypertrophy and Hyperplasia, Hypoplasia); General symptoms of viral, bacterial and fungal plant diseases; Methods of plant disease diagnosis- Histochemical, Serological and PCR techniques. Culture techniques.	5
III	Plant Disease Epidemiology Epidemics and factors affecting the development of epidemics; Epidemic assessment and Disease forecasting; Tools of epidemiology geographic information system (GIS), Global Positioning System (GPS), Remote sensing. Drone monitoring.	3
IV	Plant Diseases Causal organism, symptoms, disease cycle and management of the plant disease. Fungal diseases: White rust of crucifers, Tikka disease of groundnut. Bacterial diseases: Citrus canker, Black arm of Cotton. Phytoplasma diseases: Grassy shoot disease of Sugarcane, little leaf of brinjal. Nematode diseases: Root knot disease of vegetables, Soybean cyst. Viral diseases: Papaya Mosaic Disease, Yellow Vein mosaic of Bhendi.	8

V	Management of Plant Diseases Concept of integrated disease management (IDM); strategies for IDM- regulatory, cultural, physical, chemical and biological.	5
VI	Advanced Techniques Used in Plant Protection Introduction to Plant Quarantine, Quarantine Regulations Role of Technology in disease Forecasting. Plant disease clinics. Role of secondary metabolites and phytoalexins. Use of nanoparticles in pest and disease management.	5

Learning Resources:

Sr. No.	Reference Books
1	A.V.S.S. Sambamurty (2010) Principles of plant pathology, Wiley distributor.
2	Agrios G.N. (2005). Plant Pathology. 5th Edition, Elsevier.
3	Cooke, B.M., Jones, D.G., Kaye, B. (2007) The Epidemiology of Plant Diseases, 2nd ed. Springer.
4	Gupta V. K, Paul T S, (2004). Fungi & Plant diseases. Kalyani publishers
5	Gupta, V. K. and Sharma, R.C. (2020) Integrated Disease Management and Plant Health, Scientific Publishers, India.
6	Kapoor, A.S. and Banyal, D.K. (2012). Plant Disease Epidemiology and Management, AbeBooks.
7	Madden, L.V., Hughes, G. and Bosch, F van den (2017). The Study of Plant Disease Epidemics, APS Publications.
8	Nagrajan S. & Murlidharan K. (1995). Dynamics of plant diseases Allied Publishers, New Delhi.
9	Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi and their Allies. (2nd Edition), Medtech Publishers, Delhi.
10	Sharma, P.D. (2014). Plant Pathology. Rastogi Publications, Meerut.
11	Singh R.S. (2018). Plant Diseases. 10th Edition Medtech, New Delhi.
12	Singh R. S. (2019) Introduction to Principles of Plant Pathology 4Ed (PB2019) Paperback
E-Resources	https://plantclinic.nmsu.edu/ https://www.apsnet.org/Pages/default.aspx https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-353-Basics of Plant Biotechnology	
	Major-Theory	
	Number of Credits: 02	
	Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define biotechnology and identify the concept of plant genetic engineering	1
CO2	Explain the concepts of recombinant DNA technology, phytoremediation and nano-biotechnology.	2
CO3	Apply the techniques of plant tissue culture and plant cell culture.	3
CO4	Compare the different aspects of plant biotechnology with respect to fermentation technology, plant tissue culture and genetic engineering.	4

BOT-353-Basics of Plant Biotechnology
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	Biotechnology Introduction and definition Applications in agriculture, industry and medicine. Bioinformatics - NCBI and concept of 'omics' Use of bioinformatics tools	03
II	Plant Genetic engineering Steps involved in recombinant DNA technology Tools used for gene cloning Restriction enzymes, vectors - plasmids and bacteriophage Insertion and ligation of insert in suitable vector Screening and selection of recombinants based on chromogenic substrates Direct gene transfer methods - Electroporation and Biolistic method Agrobacterium mediated gene transfer in plants Applications of plant genetic engineering with respect to pest resistance - Bt. Cotton improved quality traits - Golden rice Introduction to CRISPR-CAS technology	10
III	Plant tissue culture Concept of totipotency Aseptic techniques in plant tissue culture, types of media and media components, sterilization, explant preparation and inoculation Organogenesis - Zygotic and Somatic embryogenesis Protoplast isolation, culture and fusion Production of somatic hybrids and cybrids and their applications Synthetic seeds Applications of tissue culture - Micropropagation and Stages of Micropropagation, organ culture and haploids Germplasm conservation and cryopreservation	05

IV	Plant Cell culture Introduction - Callus culture and suspension culture Types of suspension culture - Batch culture and Continuous culture. Secondary metabolite production Applications of plant cell culture	04
V	Phytoremediation Definition and concept Methods of Phytoremediation - Rhizofiltration, Phytoextraction, Phytodegradation and Phytostabilization.	03
VI	Applications of Biotechnology in industry Introduction to fermentation technology Principles of microbial growth Use of Bioreactors (Stirred tank and tubular tower) Applications with respect to antibiotics, ethanol and citric acid production	03
VII	Introduction to Nanobiotechnology Definition and concept Applications of nanotechnology in fertilizers and pesticides	02

Learning Resources:

Sr. No.	Reference Books
1	Dube R.C. (2008)- A textbook of Biotechnology, S.Chand Publication
2	Gupta P.K. (2012) Elements of Biotechnology
3	Kumar H.D.(2002)- A textbook of Biotechnology 2 nd Edn., East Press Private Ltd New Delhi
4	Ramawat K.G. (2003)- Plant Biotechnology, S Chand Publication
5	Bhojwani S.S. and Razdan M.k. (1996) - Plant tissue culture: Theory and Practice, Elsevier Science, Amsterdam.
6	Chawla H.S., (2007). Introduction to Plant Biotechnology. CRC Press, New Delhi.
7	Kalyan Kumar De(1997)- Plant tissue culture
8	Satyanarayan U. (2013)- Biotechnology
9	Trivedi P.C.(2000)- Plant biotechnology, Panima Publishing Corporation
E- Resources	https://www.nature.com/articles/s41598-022-09066-3/ https://medlineplus.gov/genetics/understanding/genomicresearch/genomeediting/ https://www.nature.com/scitable/knowledge/library/phytoremediation-17359669/

	BOT-354-Medico Botany Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify herbal drugs and outline the modern extraction technique.	1
CO2	Classify crude drugs and the active principles of secondary metabolites.	2
CO3	Explain Ayurvedic principles and various Ayurvedic formulations, and their uses in medicine.	3
CO4	Analyze methods for the cultivation, collection, and processing of herbal drugs, including factors affecting cultivation and drug preservation.	4

**BOT-354-Medico Botany
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Plant based drugs History, definition and Scope of Pharmacognosy Traditional and alternative systems of medicine Classification of crude drugs Concept of active principle, and Introduction of broad class of secondary metabolites: Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins	6
II	Ayurvedic Pharmacy Introduction Tridosha concept, Humoral, Indigenous Systems of medicine (Ayurveda, Siddha, Unani, Homeopathy) Ayurvedic principles- Rasa, Guna, Vipaka, Virya, Prabhava, Ayurvedic formulations – Asava, Arishta, Kvatha, Churna, Ksharas, Lehya, Vatika, Taila, Bhasma,	4
III	Cultivation, collection and processing of herbal drugs Cultivation - Methods, Factors affecting cultivation Collection and Processing Collection, harvesting, drying, garbling, packing, storage of crude drugs.	4
IV	Analytical Pharmacognosy Drug adulteration : Types of Adulteration Methods of drug evaluation- Morphological, Microscopic, Chemical, Physical and biological methods of drugs Analytical Evaluation (TLC, HPLC, GCMS, LCMS, NMR, IR)	6
V	Study of Medicinally Important Drugs Pharmacognostic studies of some drugs: w.r.t. Geographical distribution, cultivation, collection, macroscopic and microscopic characters, commercial products if any, chemical constituents, chemical tests, therapeutic uses, commercial varieties, adulterants and substitutes.	7

	Root Drugs: <i>Asparagus</i> (Shatavari), Rhizome Drugs: <i>Acorus</i> (Vekhand), Stem Drugs: <i>Ephedra</i> (Somlata), Bark Drugs: <i>Saraca</i> (Ashok), Leaf Drugs: <i>Adhatoda</i> (Adulsa), Flower Drugs: <i>Woodfordia</i> (Dhayti), Fruit Drug: , <i>Cardamomum</i> (<i>Elaichi</i>), Seed Drugs : <i>Trigonella</i> (Methi), Anticancer drug- <i>Nothopoditis</i> (Narkya), Antidiabetic drug- <i>Syzygium</i> (Jamun) Antimalarial drug - <i>Artemisia</i> (Damanak)	
VI	Conservation of medicinal plants Case study - Case study- Exploring the Riches of <i>Rauvolfia serpentina</i> : Botany, Pharmacology, and Conservation Perspectives.	3

Learning Resources:

Sr. No.	Reference Books
1	A Pharmacognosy and Pharmacobiotechnology. New Age international (P)
2	Limited, Publishers (formerly wiley Eastern Limited).
3	Kokate C.K. Practical Pharmacognosy, Vallabh prakashan, New Delhi,
4	Kokate C.K. Purohit A.P. and Gokhale S.B. Pharmacognosy, Nirali Prakashan pune.
5	Trease G.E. and Evans. W.C. Pharmacognosy ELBS Twelfth Edition.
6	Tyler V.E Brady L,R and Robbers J.E. Pharmacognosy Lea and Febiger.
7	Philadelphia.8th edition KM Varghese and Co.Mumbai.
8	Vaidya S.S. and Dole.V.A. Bhaishyajakalpana, Anmol Prakashan, pune.
9	Wallis,T.E. Test books of pharmacognosy CBS publishers and distributors New Delhi (Latest Edition).
10	Dr.Kuntal Das. Pharmacognocoy and Phytochemistry-I
E-Resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-355-Biofertilizers Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the concepts of biofertilizers, microbial consortium and organic farming.	1
CO2	Discuss the characteristics, method of isolation, identification of biofertilizers and nodulation process in <i>Rhizobium</i> .	2
CO3	Interpret the mechanism of symbiotic nitrogen fixation in <i>Rhizobium</i> , mass multiplication of Cyanobacterial, Bacterial biofertilizers and inoculum production in Mycorrhiza.	3
CO4	Relate to various methods of organic farming, importance, field application methods and significance of organic farming and biofertilizers.	4

BOT-355-Biofertilizers
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	Biofertilizers Introduction, advantage over chemical fertilizers, significance. General account of biofertilizers organisms - Blue Green Algae (Cyanobacteria), Bacteria, and Mycorrhizae.	2
2	Blue Green Algae (Cyanobacteria) as biofertilizer General account of BGA used as biofertilizers: <i>Anabaena</i> , <i>Cylindrospermum</i> , <i>Gloeocapsa</i> , <i>Lyngbya</i> , <i>Nostoc</i> , <i>Plectonema</i> and <i>Tolypothrix</i> . Algalization, isolation, mass multiplication, importance in rice cultivation, symbiotic association of BGA: <i>Azolla</i> - <i>Anabaena</i> as biofertilizers, Mass cultivation of <i>Azolla</i> , Field application of Cyanobacterial biofertilizers.	5
3	Bacterial biofertilizers: Symbiotic Nitrogen fixers <i>Rhizobium</i> - infection in legumes, nodulation process and mechanism of symbiotic nitrogen fixation. <i>Rhizobium</i> - characteristics, isolation, identification, mass multiplication, carrier-based inoculant, methods of application. <i>Frankia</i> - characteristics, Actinorrhizal symbiosis	6
4	Bacterial biofertilizers: Non-Symbiotic Nitrogen Fixers Free living: <i>Azospirillum</i> , Associative: <i>Azotobacter</i> characteristics, isolation, identification, mass multiplication, carrier-based inoculant.	5
5	Mycorrhizal fungi as biofertilizers Types of mycorrhizal association (Ectomycorrhiza, Endomycorrhiza). Arbuscular mycorrhizae: Methods of isolation (wet sieving and decanting) and method of inoculum production (Pot culture and root culture). Role of Arbuscular mycorrhizal fungi in phosphorus nutrition, growth and yield of crop plants.	5
6	Microbial Consortium Introduction and application	2
7	Organic farming	5

	Introduction to organic farming, green manuring, bio-composting, types and method of vermicomposting, field application.	
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Learning Resources:

Sr. No.	References
1	Dubey, R. C., 2005, A Text book of Biotechnology, S. Chand & Co., New Delhi
2	Kumaresan, V., 2005, Biotechnology, Saras Publications, New Delhi.
3	John JothiPrakash, E., 2004, Outlines of Plant Biotechnology, Emkay Publication, NewDelhi.
4	Sathe, T. V., 2004, Vermiculture and Organic Farming, Daya Publishers.
5	SubhaRao, N. S., 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6	Vyas, S. C., Vyas, S. and Modi, H. A., 1998, Bio-fertilizers and Organic Farming, Akta
7	John JothiPrakash, E., 2004, Outlines of Plant Biotechnology, Emkay Publication, NewDelhi.
8	Sathe, T. V., 2004, Vermiculture and Organic Farming, Daya Publishers.
9	SubhaRao, N. S., 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
E-resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT-356-Computational Botany Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	State the basics and uses of statistical analysis.	1
CO2	Generalize different statistical methods for data analysis.	2
CO3	Compute the analysis of biological data using basic statistical tools and MS-Excel.	3
CO4	Integrate different statistical tools to draw conclusion from data.	4

**BOT-356-Computational Botany
(Elective-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Introduction to Biostatistics Definition & Statistical terms Scope, applications and uses of biostatistics	2
II	Sample and sampling Definition, Sampling unit, sample and population Types of sampling Random sampling – with replicates, without replicates, systematic sampling, stratified sampling Non-random sampling- Purpose, quota sampling	5
III	Collection and representation of data a. Classification of data b. Methods of representation of statistical data Tabular and graphical (Histogram, Frequency polygon, Frequency curve, Scatter or dot diagram) Merits and demerits Diagrammatic representation of data (Line diagram, Bar diagram, Pie diagram) Use of MS-Excel for data representation	5
IV	Measures of central tendency Simple arithmetic mean, its merits and limitations Median and mode, their merits and limitations Calculation of Mean, Median and Mode in MS-Excel	4
V	Measures of dispersion Meaning of dispersion Range, Mean deviation and standard deviation, Variance Calculation of Standard Deviation and variance in MS-Excel	4
VI	Tests of significance of mean Introduction, Statistic and its standard error Meaning of statistical hypothesis, level of significance, null hypothesis and alternative hypothesis Student's 't' test: unpaired and paired test T test as a test of goodness of fit and its significance	4

VII	Open Source Databases PubChem patents.google.com Ayush Database	2
VIII	Public platforms and AI sites inaturalist.org discoverylife.com gbif.org Photo Identification – identify.plantnet.org AI platform – Botany Buddy - bottanibuddy.com	4

Sr. No.	References
1	Bailey, N. - Statistical methods in Biology, Cambridge University Press.
2	Panse and Sukatme – Statistical methods in Biology, Indian Council of Agricultural Research.
3	Snedecore, G.W. and Cochran- Statistical methods, Wiley-Blackwell.
4	Purohit S.G., V.D. Ranade, A.V.Dusane -Introduction to Biometry Narendra Prakashan
5	Veer Bala Rastogi- Fundamentals of Biostatistics, ANE Books.
6	Wayne W. Daniel-Biostatistics, Wiley Publishers.
7	Pranab Kumar Banerjee-Introduction to biostatistics, S Chand & Company.
8	Khan and Khanum- Fundamentals of biostatistics, Ukaaz Publications
9	B L Agarwal- Basic statistics, New Age International Private Limited.
10	Wayne W Daniel- Biostatistics-Basic Concepts and Methodology for the Health Sciences, Wiley Publishers.

	BOT-357-Seed Technology Elective-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall the concepts of seed, classes of seed and seed technology.	1
CO2	Discuss the components of seed technology.	2
CO3	Apply knowledge to describe seed production, processing, sampling, testing and certification.	3
CO4	Explain the significance of seed and seed technology.	4

BOT-357-Seed Technology
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of hours
1	Introduction to Seed Concept of seed, Definition, and types of seed (based on endosperm and number of cotyledons), phases of seed germination. Seed Dormancy- concept, types and causes of seed dormancy. Methods to break seed dormancy, Advantages and disadvantages of seed dormancy	04
2	Seed Technology Concept, difference between seed and grain, seed quality characteristics, role and goals of seed technology.	02
3	Classes of Seed Nucleus Seed, Breeder Seed, Foundation Seed, Certified Seed, Truthful Seed	02
4	Components of Seed Technology Seed Production, Seed processing and storage, Seed testing and certification, Seed marketing and distribution. General Principles in seed production Seed source, Land requirements, Isolation of seed crop, Cultural practises, rouging, weed control, disease and insect control, harvesting, drying, storage.	04
5	Seed Production Pulses: Gram, Oil crops: Groundnut, Fruit vegetables: Okra, Leafy vegetables: <i>Trigonella</i> (Methi)	04
6	Seed Processing Drying, Cleaning and grading, Testing, Treating, Bagging and labelling.	02
7	Seed Sampling and Testing Seed Sampling - sampling in laboratory (Mechanical Divider Method: Borner seed divider and Gamet seed divider), random cup method, Spoon method, The Hand Halving method, Seed testing -Physical Purity Analysis, Seed germination test (Paper, Sand and Soil), Seedling Evaluation, Seed viability test, Seed health test, Seed moisture content (Air oven Method, Moisture meters).	06
8	Seed Certification and Seed Production Organizations Field Inspection, Inspection during seed processing, Introduction to The Seed Act (1966)	04

	Seed Production Organizations- National Seed Corporation (NSC), State Seed Corporation (SSC), Seed Certification Agency (SCA), Private Seed Companies	
9	Concept of Advanced Seed Seed longevity behaviour: orthodox and recalcitrant seed, Seed pelleting and coating (Artificial or synthetic seed production).	02

Learning Resources:

Sr. No.	Reference Books
1	Verma and Agarwal – (2006) Seed Technology Demand forecasting, Seed pricing, projection of supply and demand for different kind of seeds. S.Chand and Company, New Delhi.
2	Rattan Lal Agarwal – (2021) Seed Technology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3	Singh B.D– (1996) Plant Breeding – Principles and methods. Kalyani Publications, Ludhiana.
4	Chopra, V.L. (2023). Plant Breeding: Theory and Practice 2nd Restructured Edition, New India Publishing Agency, New Delhi.
E-resources	https://egyankosh.ac.in https://www.swayamprabha.gov.in

	BOT 361-Botany Practical -8 Major-Practical	
	Number of Credits: 02 Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify and classify plants from families based on their morphological characters.	1
CO2	Differentiates and explains plant pathogens and diseases with the help of symptoms.	2
CO3	Implement the use of vegetative and reproductive characters to identify plant species and genera and prepare artificial keys.	3
CO4	Evaluate Koch's Postulates and explain the procedure of fungicides preparation. Assess the methods of fossilization and review specimens like Rhynia, Calamites, and Pentoxylon using slides or specimens.	4

**BOT 361-Botany Practical -8
(Major-Practical)**

Unit No.	Title of Unit and Contents
1	Study of Polypetalae: Magnoliaceae, Capparidaceae
2	Study of Polypetalae: Rosaceae, Annonaceae
3	Study of Gamopetalae: Acanthaceae, Lamiaceae
4	Study of Gamopetalae: Bignoniaceae, Verbinaceae
5	Study of Apetalae: Nyctaginaceae, Polygonaceae
6	Study of Monocotyledonae: Orchidaceae, Cannaceae
7	Identification of plants with the help of suitable flora (Genus and Species)
8	Preparation of artificial key based on vegetative and reproductive characters.
9	Study of methods of fossilization: impression, Compression, Petrification, coal ball
10	Study of the following with the help of slides and /or specimens: Rhynia, Calamites, Pentoxylon
11	Study of bacterial diseases through the specimens/photographs- Citrus Canker and Angular leaf spot /Black arm of Cotton. Study of Mycoplasma diseases through the specimens/photographs- Grassy shoot of sugarcane and Little leaf of Brinjal. Study of viral Diseases through specimens/photographs- Papaya Mosaic Disease and vein clearing of Bhindi.
12	Demonstration of Koch's Postulates.
13	Preparation of Bordeaux mixture, Neem decoction
14	Study of Fungicides and Microbial pesticides.
15	Visit to BSI

	BOT-362-Botany Practical -9	
	Major-Practical	
	Number of Credits: 02	
	Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall handling procedures for lab equipment.	1
CO2	Explain preparation of stock solutions and media.	2
CO3	Apply sterile techniques for culturing leaf, shoot tip, and embryo culture and fungal pathogens.	3
CO4	Discuss plant diseases and their symptoms and analyse DNA electrophoresis and phytoremediation results.	4

BOT-362-Botany Practical -9
(Major-Practical)

Practical no.	Title of the Practical
1.	Handling of equipment (Weighing balance, Autoclave, Micropipette, pH meter, spectrophotometer, Autoclave and Laminar air flow chamber)
2.	Preparation of stock solutions, sterilization and preparation of MS slants.
3.	Initiation of leaf culture/ meristem culture
4.	Initiation of embryo culture (Groundnut and Maize)
5.	Demonstration of separation of DNA by agarose gel electrophoresis
6.	Preparation of fermentation medium and inoculation of <i>Aspergillus niger</i> spores.
7.	Production and estimation of citric acid
8.	Demonstration of phytoremediation
9.	Retrieval of data from NCBI
10.	Demonstration of transgenic plants.
11.	Preparation of fungal culture medium (PDA/CDA) for isolation of plant pathogens.
12.	Study of Culture technique for preparation of pure culture - Serial dilution method, Streak plate, Pour plate and Spread plate techniques.
13.	Study of White rust of crucifers, Symptoms on leaves and hypertrophy with the help of specimens/ photographs. Study of causal organism (<i>Albugo candida</i>) with the help of section mount.
14.	Study of Tikka disease of groundnut. Symptoms on leaves with the help of specimens/ photographs. Study of causal organism (<i>Cercospra arachidicola</i>) with the help of section mount.
15.	Visit to tissue culture /Plant pathology laboratory.

Note: 10 Compulsory Practicals + 1 Activity (Equivalent to 2 Practicals)

	BOT-382-Botany Practical-10 VSC-Practical	
	Number of Credits: 02 Number of Hours: 60	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify and list the components for preparing various food and vegetable products by processing it.	1
CO2	Differentiate various processing technique.	2
CO3	Carry out preparation of different food and vegetable products.	3
CO4	Relate prepared products with available standard products.	4

**BOT-382-Botany Practical-10
(VSC-Practical)**

Practical No.	Title of the Practical
1.	Harvesting, post-harvest handling & methods of preservation of fruit & vegetables
2.	Preparation of jam
3.	Preparation of different types of squash
4.	Processing of tomato products; Ketchup
5.	Preparation of pickle
6.	Preparation of dehydrated vegetables.
7.	Preparation of fruit jelly
8.	Preparation of marmalades
9.	Preparation of murabba
10.	Preparation of candied fruit and fruit bars
11.	Osmotic dehydration of fruit
12.	Visit to fruit processing industry

Note: 10 Compulsory Practicals + 1 Activity (Equivalent to 2 Practicals)

	BOT-371-Plant Biotechnology Minor-Theory	
	Number of Credits: 02 Number of Hours: 30	
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Identify and define the basic key tools and methods used in plant biotechnology and genetic engineering	1
CO2	Explain the significance of genetic modification in plant biotechnology.	2
CO3	Interpret the concept of plant tissue culture, phytoremediation, single cell proteins and biofertilizers.	3
CO4	Integrate advanced plant biotechnology methods to solve agricultural challenges.	4

**BOT-371-Plant Biotechnology
(Minor-Theory)**

Unit No.	Title of Unit and Contents	No. of hours
I	Biotechnology Introduction, definition, application with respect to agriculture and industry	02
II	Basics of plant genetic engineering Gene cloning Introduction to restriction enzymes, vectors - plasmid PUC and phage. Screening and selection methods with respect to chromogenic substrates. Direct gene transfer methods. Applications with respect to Bt. Cotton and Golden Rice	09
III	Plant tissue culture Concept of totipotency Aseptic techniques in plant tissue culture, composition of media, types of media and media components, sterilization, explant preparation and inoculation Organogenesis - somatic and zygotic embryogenesis Protoplast isolation, culture and fusion Somatic hybrids and cybrids. Applications of tissue culture - Micropropagation, haploids and synthetic seeds Germplasm conservation and cryopreservation.	10
IV	Biofertilizers Nitrogen fixing microorganisms (symbiotic and non-symbiotic free living) Phosphate solubilizers. Plant growth promoting rhizobacteria producers	03
V	Phytoremediation Definition and concept Methods of Phytoremediation- Rhizo-filtration, Phytoextraction, Phytodegradation	03

VI	Single cell proteins Introduction, Production of SCP from algae - Spirulina and fungi - Yeast Applications of SCP	03
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Learning Resources:

Sr. No.	References
1	Dube R.C. (2008)- A textbook of Biotechnology, S.Chand Publication
2	Gupta P.K. (2012) Elements of Biotechnology
3	Kumar H.D. (2002)- A textbook of Biotechnology 2nd Edn., East Press Private Ltd New Delhi
4	Ramawat K.G. (2003)- Plant Biotechnology, S Chand Publication
5	Bhojwani S.S. and Razdan M.k. (1996)- Plant tissue culture: Theory and Practice, Elsevier Science, Amsterdam.
6	Chawla H.S., (2007). Introduction to Plant Biotechnology. CRC Press, New Delhi.
7	Kalyan Kumar De (1997)- Plant tissue culture
8	Satyanarayan U. (2013) - Biotechnology
E-Resources	1. https://www.nature.com/articles/s41598-022-09066-3 2. https://www.nature.com/scitable/knowledge/library/phytoremediation-17359669

BOT-395 OJT (On Job Training-Theory/Practical) Theory/Practical
Number of Credits: 4 No. of Hours: 120